

The Vulnerability of the Older Child

A New Approach to Identifying Ages When Children Are Most Susceptible to Lead Effects

Watch a toddler, and you quickly see why small children are so vulnerable to environmental exposures: most of what they touch goes right into their mouths. It's no wonder, then, that lead levels generally peak at age 2 years, which is when health officials recommend children be tested for elevated blood lead. But new research shows that 5- to 6-year-olds may be particularly vulnerable to the cognitive

Although blood lead concentrations tend to decline after toddlerhood, older children may be more susceptible to adverse effects of exposure.



and behavioral effects of lead and should be tested as well if such problems are apparent [*EHP* 117:1309–1312; Hornung et al.].

Previous studies have suggested that IQ scores at ages 5–7 years are more strongly associated with concurrent blood lead concentrations than with concentrations measured at age 2. However, children's blood lead concentrations during infancy are strongly associated with concentrations at older ages—meaning, for instance, a highly exposed toddler still tends to be highly exposed at age 6. This “serial correlation” makes it difficult to determine whether lead has a cumulative effect or whether effects of lead differ according to age.

In the current study, researchers analyzed blood lead concentration data for 462 children who participated in either the Cincinnati Lead Study, which enrolled children from 1979 to 1984, or the Rochester Longitudinal Study, which enrolled children from 1994 to 1995. In both studies the children's blood lead was measured every year from infancy to age 6. The children also took IQ tests around age 6.

To study effects of lead at different ages while accounting for correlations in lead levels over time, the researchers estimated effects of the ratio of the child's blood lead at age 2 relative to his or her blood lead at each subsequent age (3–6 years). As the ratio of age 6:age 2 blood lead increased, IQs declined even after controlling for average lead exposure at all ages as well as a range of other covariates. In addition, children who had relatively higher lead exposure at age 5 or 6 compared with age 2 had significantly higher arrest rates for criminal behavior in adulthood than other children.

The results suggest that blood lead testing and efforts to reduce exposure should continue as children reach school age. Moreover, lead testing of school-age children with cognitive or behavioral problems may help identify underlying causes of difficulties teachers or parents are seeing.

Tina Adler first wrote for *EHP* about the Clinton–Gore environmental agenda in 1993. She is a member of the National Association of Science Writers and the American Society of Journalists and Authors.

Chemicals Policy Gap

Toward Stronger Regulation in the United States

Chemicals policy in the United States is in need of profound change for both environmental health and economic reasons, according to a review of how the U.S. chemical industry currently is regulated [*EHP* 117:1202–1209; Wilson and Schwarzman]. The 1976 Toxic Substances Control Act (TSCA), which provides the chief legal authority for regulating industrial chemicals in the United States, is antiquated and ineffective, according to the authors.

Reform of TSCA is especially urgent in view of the European Union's passage in 2006 of the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation. REACH's more stringent and transparent rules for regulating industrial chemicals could put the United States at risk of becoming a market for hazardous chemicals that become banned in Europe. Without a parallel transformation in U.S. chemicals policy and a strong commitment to green chemistry, the United States could face growing health and environmental problems and will have difficulty meeting the challenges of environmental and economic sustainability, the authors write.

TSCA currently requires chemical producers to disclose little toxicologic or other test data, creating a data gap that prevents the public and downstream users of chemicals from making informed purchasing decisions. The U.S. Environmental Protection Agency bears the burden of proving that a chemical should be regulated (as opposed to the manufacturer proving that the chemical need not be regulated),

and a lack of governmental tools to evaluate and mitigate chemical hazards has produced a safety gap. In concert with the first two gaps, the lack of investment in green chemistry research and development has produced a technology gap, with the United States at risk of falling behind the European Union and other industrialized nations in this area.

The authors argue that the three gaps have produced a chemicals market that values function, price, and performance over safety while externalizing the costs of chemically related health and environmental damage to the public. These market and regulatory conditions also pose a key barrier to the scientific and commercial success of green chemistry in the United States and could hinder the U.S. chemical industry's global competitiveness as green chemistry technologies accelerate under REACH.

Global chemical production is expected to double in the next 24 years, according to the United Nations and other sources, and the Environmental Protection Agency has estimated the United States will need 217,000 new hazardous waste sites in the next 20 years. Concluding that “the vast potential of green chemistry remains untapped,” the authors call for “a chemicals policy that departs markedly from the federal policies of the last 30 years, of which TSCA is emblematic.” Taking advantage of this opportunity, they write, would propel the United States toward new chemistries that are safer for occupational, environmental, and public health—the cornerstone of a truly sustainable society.

Valerie J. Brown, based in Oregon, has written for *EHP* since 1996. In 2009 she won a Society of Environmental Journalists' Outstanding Explanatory Reporting award for her writing on epigenetics.

A Framework to Monitor Toxics Measuring the Health Impact of Chemical Bans

One of the tasks mandated by the Stockholm Convention on Persistent Organic Pollutants is to determine if bans on toxic substances are effective in reducing contamination in people. But assessing such trends in diverse global populations is difficult because researchers must use changes in the average levels of contaminants measured in groups of people at different points in time—known as cross-sectional trend data—to estimate how levels are changing in individuals over time. A team of Swiss researchers has developed a pharmacokinetic model framework that may help improve the use of cross-sectional trend data in assessing the effects of chemical bans [EHP 117:1280–1286; Ritter et al.].

Among the parameters required by the model are the rate of elimination of the contaminant from the body and the rate of decline of individual intake of the contaminant once a ban takes effect. Additional parameters include body weight and the fraction of the body weight that is lipid. The authors tested their formulas with sample cases involving *p,p'*-DDT and *p,p'*-DDE from selected Swedish and U.K. populations, and found that the outcomes matched fairly well with concentrations identified in earlier studies.

As with any model, however, a key to its successful application is good data for the variables included in the model. The authors note

that total diet studies, which are regularly conducted in a number of countries, are a good source of data to estimate changes in contaminant intake over time, because food is typically the primary source of ongoing exposures in postban situations.

The model assumes that cross-sectional averages used to estimate changes in contaminant levels over time are based on data from populations that are similar in age and other factors that would influence initial body burden and contaminant intake and elimination. The key is that changes in intakes be reasonably consistent among members of the population, but they need not be consistent for the population over time if data are available to estimate changes in dietary intake. Modeling data from populations that are reasonably similar with regard to these characteristics also means that results from the model will be population-specific and not necessarily applicable to other populations.

Still, the authors say the model is broadly adaptable, and the formulas can be modified to factor in considerations such as pathways other than ingestion, storage in body reservoirs other than fat tissue, and different elimination rates. To optimize the use of this model, the authors recommend that efforts to monitor toxics include regular data collection, including total diet data to estimate background levels of ongoing exposure, in young adult populations.

Bob Weinhold, MA, has covered environmental health issues for numerous outlets since 1996. He is a member of the Society of Environmental Journalists.

Southern Discomfort? PON1 Variation May Help Explain Regional CVD Risk

Age-associated rates of cardiovascular disease (CVD) are higher in the Southern states (except Florida) than anywhere else in the United States, and higher among Southern blacks than Southern whites. Animal studies suggest that higher levels of activity of the enzyme paraoxonase-1 (PON1) may lower the risk of CVD, specifically atherosclerosis, but evidence linking functional variations in PON1 to atherosclerosis risk in humans has been ambiguous. New research correlates functional variation in PON1 activity with race, which may help explain demographic variation in CVD prevalence [EHP 117:1226–1231; Davis et al.].

PON1 is carried by high-density lipoprotein in the blood and is involved in the hydrolysis, or breakdown, of oxidized low-density lipoprotein, whose buildup is considered an early step in the development of atherosclerosis. PON1 is also involved in the hydrolysis of the toxic oxon metabolites of certain organophosphate insecticides.

A single-nucleotide polymorphism at position 192 on the *PON1* gene results in two functional variations of the enzyme, the Q and R forms. Other studies have associated the R form with a greater risk of atherosclerosis. The R form also hydrolyzes chlorpyrifos oxon more effectively than the Q form, whereas both alloforms are equally effective at metabolizing diazoxon; neither hydrolyzes paraoxon quickly enough to offer protection. PON1 activity is also linked to the quantity of the enzyme in the blood, which is controlled in part by polymorphisms in the gene's promoter region and may vary by at least 13-fold among individuals.

The researchers analyzed serum samples for 200 adult black and white men and women (50 in each sex–race group) obtained from blood banks in Alabama and Tennessee. The team determined PON1 functional genotypes—RR, QR, or QQ—by measuring rates of hydrolysis of paraoxon and diazoxon. They also analyzed arylesterase activity (another measure of PON1 activity), levels of cotinine (a biomarker of smoking, which can affect PON1 levels), and C-reactive protein (a biomarker of inflammation associated with greater risk of CVD).

Forty-four percent of black subjects had higher *in vitro* rates of paraoxon hydrolysis and lower rates of diazoxon hydrolysis, consistent with the RR genotype that has been hypothesized to increase the risk of CVD. In contrast, only 7% of white subjects had activity levels consistent with the RR genotype. Black subjects also had higher levels of C-reactive protein, consistent with a greater risk of CVD. However, levels of C-reactive protein were not associated with PON1 activity. Cotinine levels indicated that all study participants were nonsmokers—possibly the result of the blood banks having screened out smokers.

The authors conclude their data support the idea that the functional RR genotype is less protective of cardiovascular health. They are working on a follow-up study of Southerners of both races and sexes where there is more information about participants' health status and medical history.

Kris S. Freeman has written for *Encarta* encyclopedia, NIH, ABCNews.com, and the National Park Service. Her research on the credibility of online health information appeared in the June 2009 *IEEE Transactions on Professional Communication*.



PON1 helps break down pesticides in the body.